



POWER SUPPLY | GENERATION | FINANCIAL | MEMBER SERVICES | RISK MANAGEMENT | SUSTAINABILITY

DOE Workshop on Electric Transmission Development and Siting Issues

November 15, 2018



Company Overview

Non-profit wholesale power supplier and services provider for 135 member municipal electric systems; members are units of local government

Established 1971

- 177 Employees
- HQ: Columbus OH

Members located in 9 states

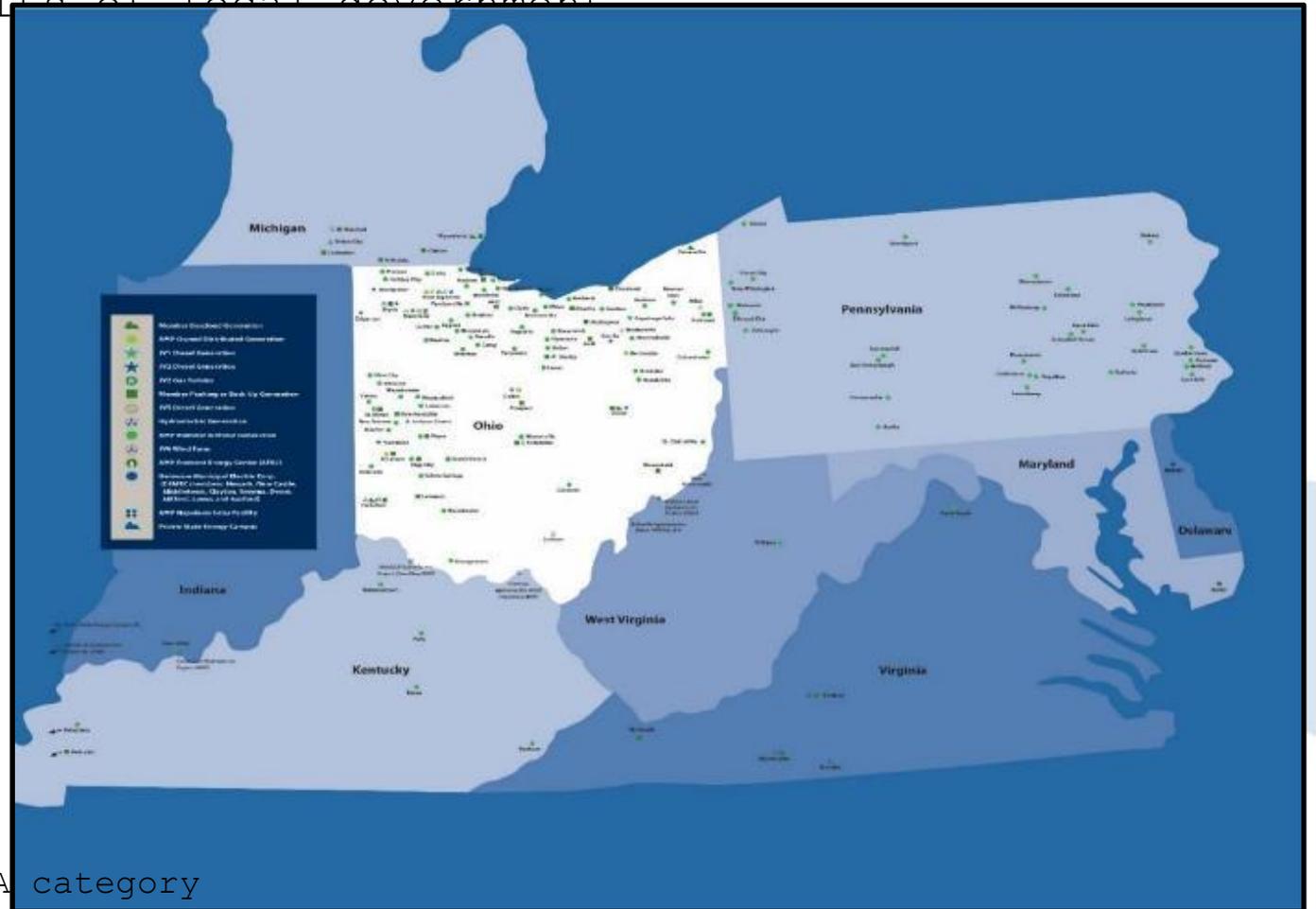
- OH, KY, PA, MI, VA, MI, DE, WV, IN
- Serving 650,000 customers
- Operate in 2 RTOs & non-market areas

21-member Board of Trustees

- Comprised of member system officials

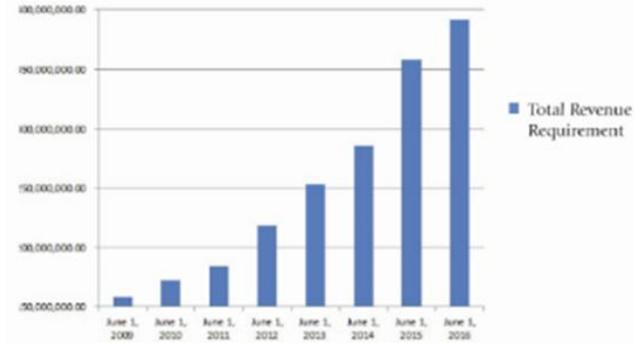
Assets Totaling \$6.2 billion

- Mixed Generation Technologies
- Diverse Energy portfolio
- 3400 MW peak load
- All project financings rated in the A category



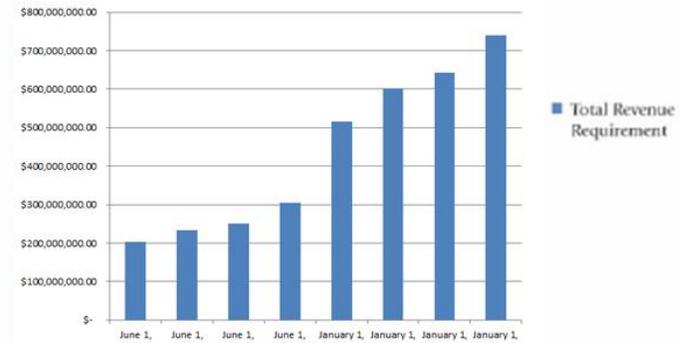
TO Revenue Requirements

PPL TRANSMISSION REVENUE REQUIREMENT



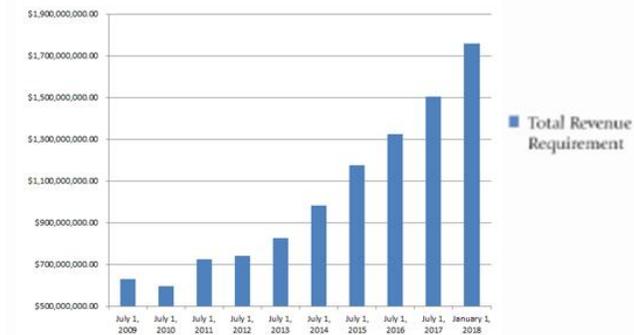
147% increase in revenue requirement from 2009 to 2016
Schedule 12 Zonal Charges as of January 2017

ATSI TRANSMISSION REVENUE REQUIREMENT



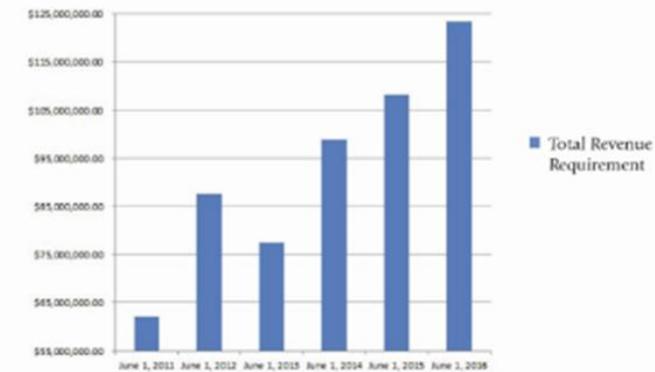
217% increase in revenue requirement from 2011 to 2018
Schedule 12 Zonal Charges as of January 2018

AEP ZONAL TRANSMISSION REVENUE REQUIREMENT



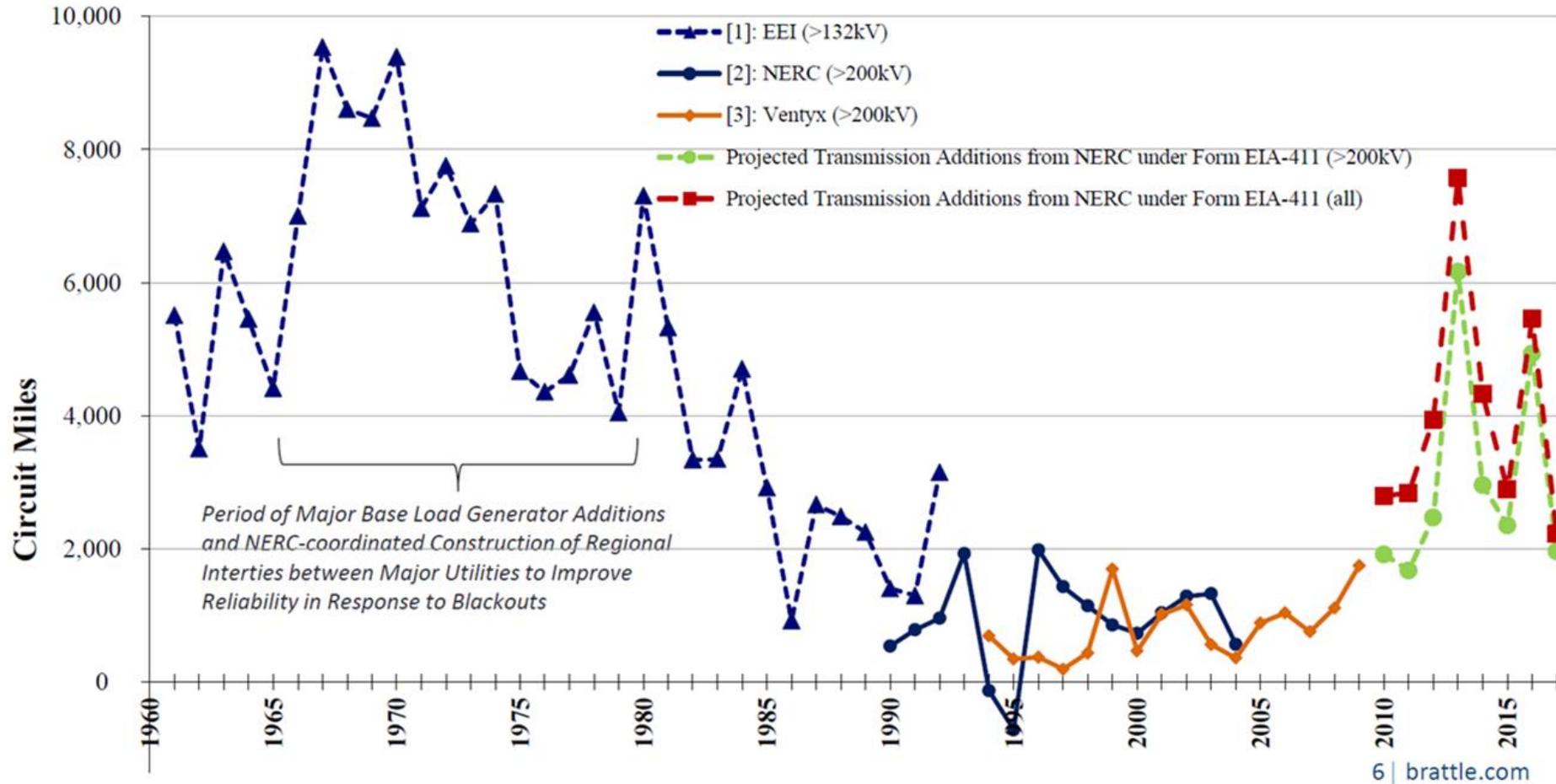
179% increase in revenue requirement from 2009 to 2018
Schedule 12 Zonal Charges as of January 2018

DUKE ZONAL TRANSMISSION REVENUE REQUIREMENT



99% increase in revenue requirement from 2011 to 2016

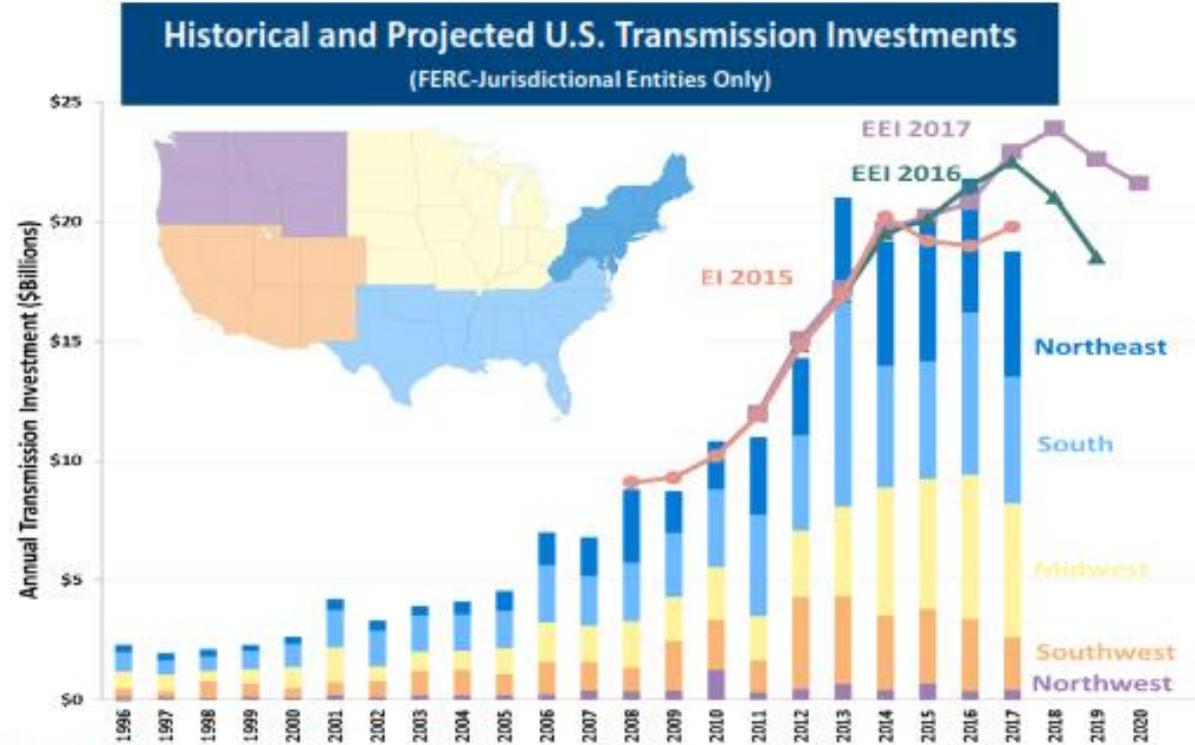
- Most of the existing grid was built 30-50+ years ago
- Even relatively high recent and projected circuit miles additions are below levels of additions in 1960s and 1970s



*Investment Trends and Fundamentals in US Transmission and Electricity Infrastructure; July 17, 2015 Brattle Presentation to JP Morgan Investor Conference

Historical Transmission Investment in the U.S. Historical and Projected U.S. Transmission Investment by FERC-Jurisdictional Entities

U.S. transmission investments have stabilized at approx. \$20 billion/year in the last five years, after rising steadily from \$2 billion/year in 1990s



Sources and Notes:

The Brattle Group, © 2018. Regional investment based on FERC Form 1 Investment compiled in Ventyx's Velocity Suite, except for ERCOT for years 2010 - 2017, which are based on ERCOT TPIT reports. Based on EIA data available through 2003, FERC-jurisdictional transmission owners estimated to account for 80% of transmission assets in the Eastern Interconnection and 60% in WECC. Facilities >300kV estimated to account for 60-80% of shown investments. EEI annual transmission expenditures updated December 2017 shown (2011 -2020) based on prior year's actual investment through 2016 and planned investments thereafter. brattle.com | 6

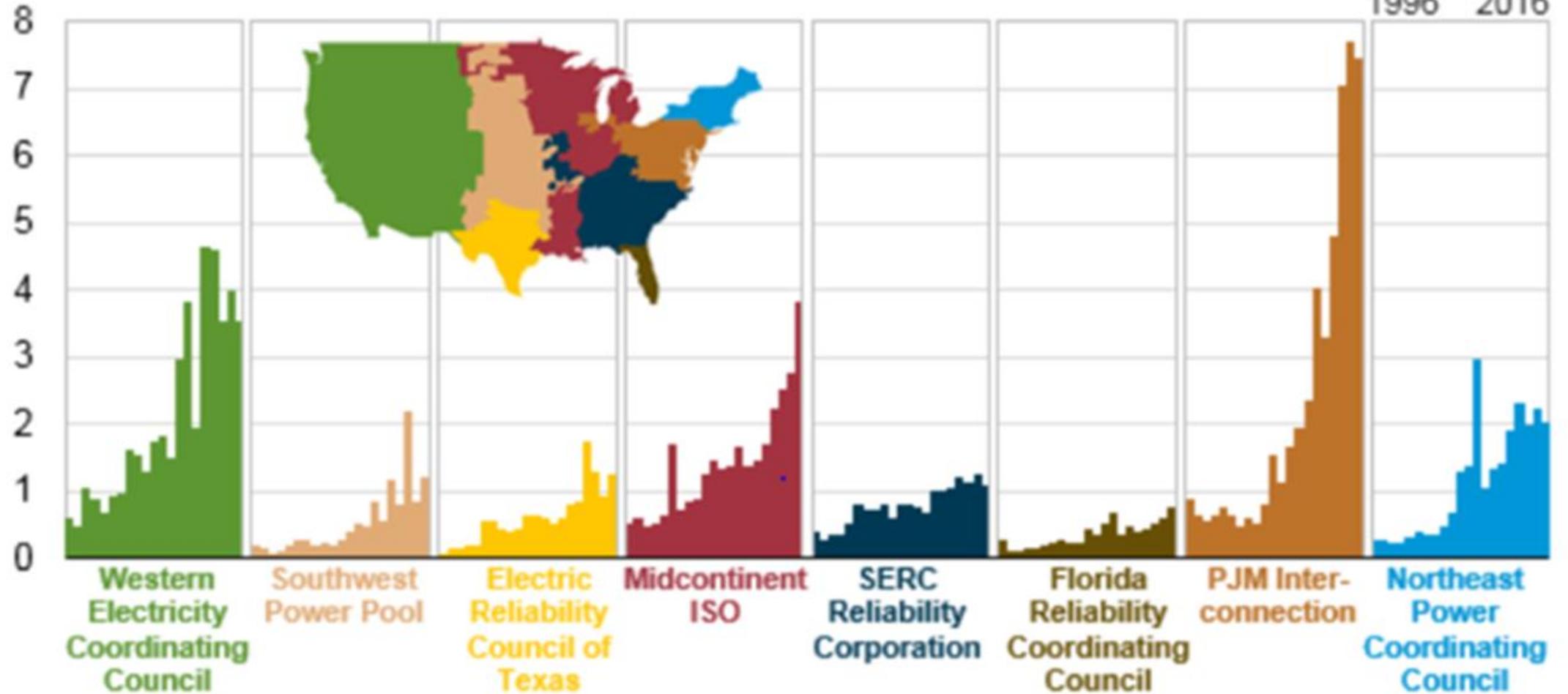
Transmission Costs are Increasing

Utility transmission investments by NERC region (1996-2016)

billion 2016 dollars



1996 2016



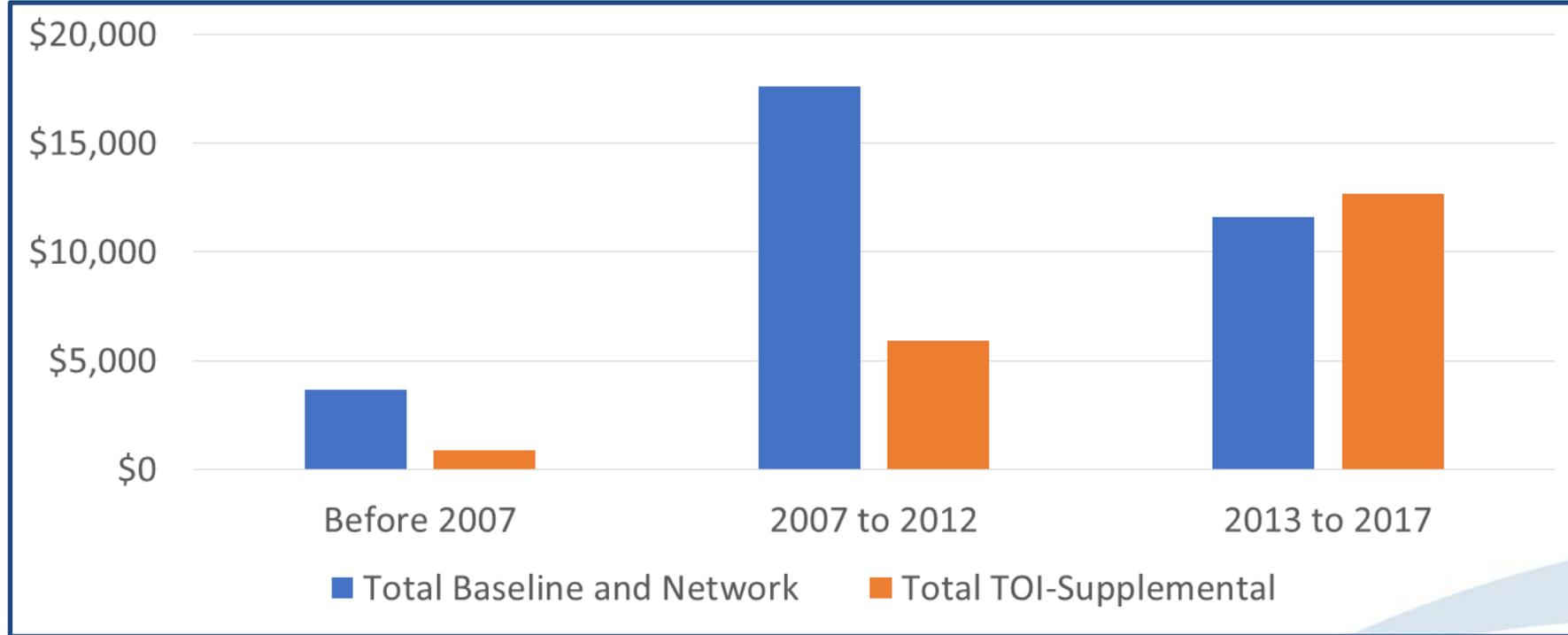
PJM Planning Process

- PJM plans to NERC, PJM and individual Transmission Owner Criteria as set forth in FERC Form No. 715. PJM also assesses operational performance, market efficiency and state initiatives.
- Additionally, Transmission Owners may propose Supplemental Projects
 - Transmission expansion or enhancement that is not required for compliance with the following PJM criteria: system reliability, operational performance or economic criteria, pursuant to a determination by PJM, and is not a state public policy project pursuant to section 1.5.9(a)(ii) of Schedule 6 of the Operating Agreement. PJM, Intra-PJM Tariffs, Operating Agreement
- Form 715 and Supplemental Projects are TO driven

Ken Rose, Summary of Findings

- Revenue Requirement and Transmission Rates for PJM increased considerably in a short amount of time—from 2009 to 2017
 - 12 TOs had a 20% or more increase in revenue requirement
 - 11 TOs had better than 20% increases in Network Integration Transmission (NIT) Rate
 - Not all TOs in PJM had such increases—several had modest or no change in NIT rate
- Transmission enhancement charges for some TOs have also increased during that same time period
 - Total Annual Revenue Requirement for transmission enhancement increased by 294.5% from 2011 to 2017

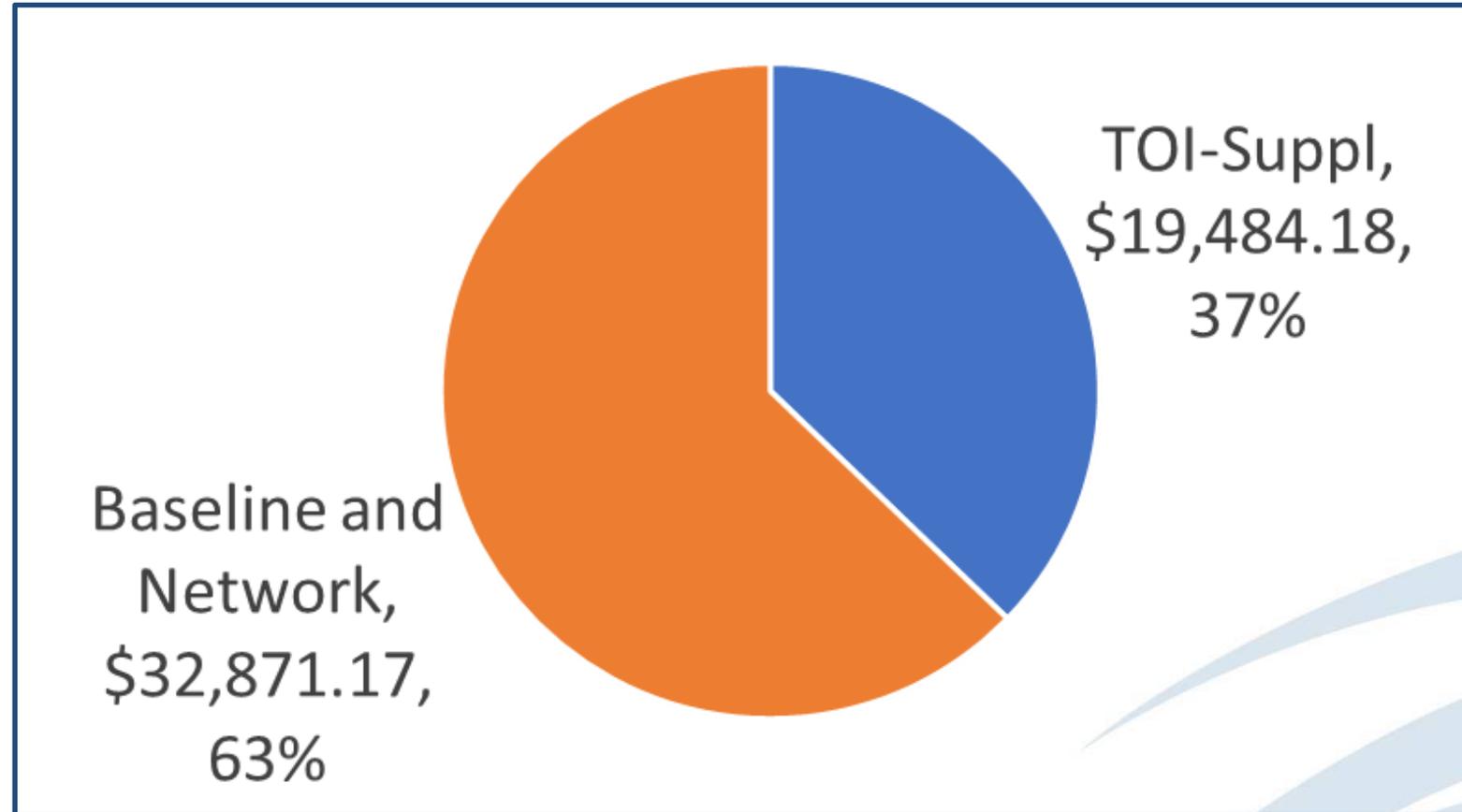
Transmission Project Estimated Cost by Year



- Through 2012, there was approximately \$21.3 billion of PJM in-service or planned baseline and network upgrades, as opposed to \$6.8 billion of TOI/Supplemental Projects
- After 2012, there was approximately \$11.6 billion of PJM in-service or planned baseline and network upgrades as opposed to approximately \$12.7 billion of Supplemental Projects
- With the exception of 2016, the amount of Supplemental Projects has steadily increased each year

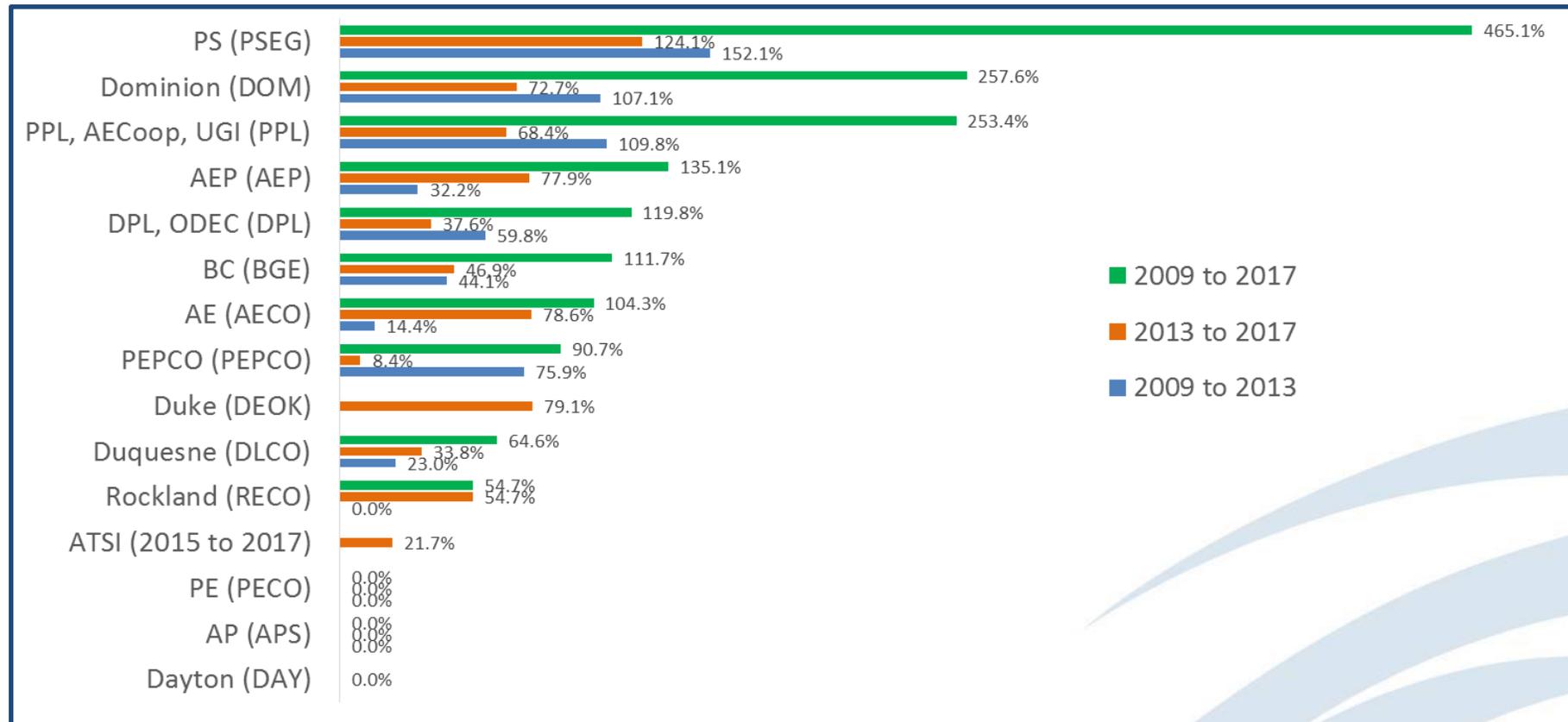
in millions of dollars

Total Transmission Construction Estimated Costs by Category



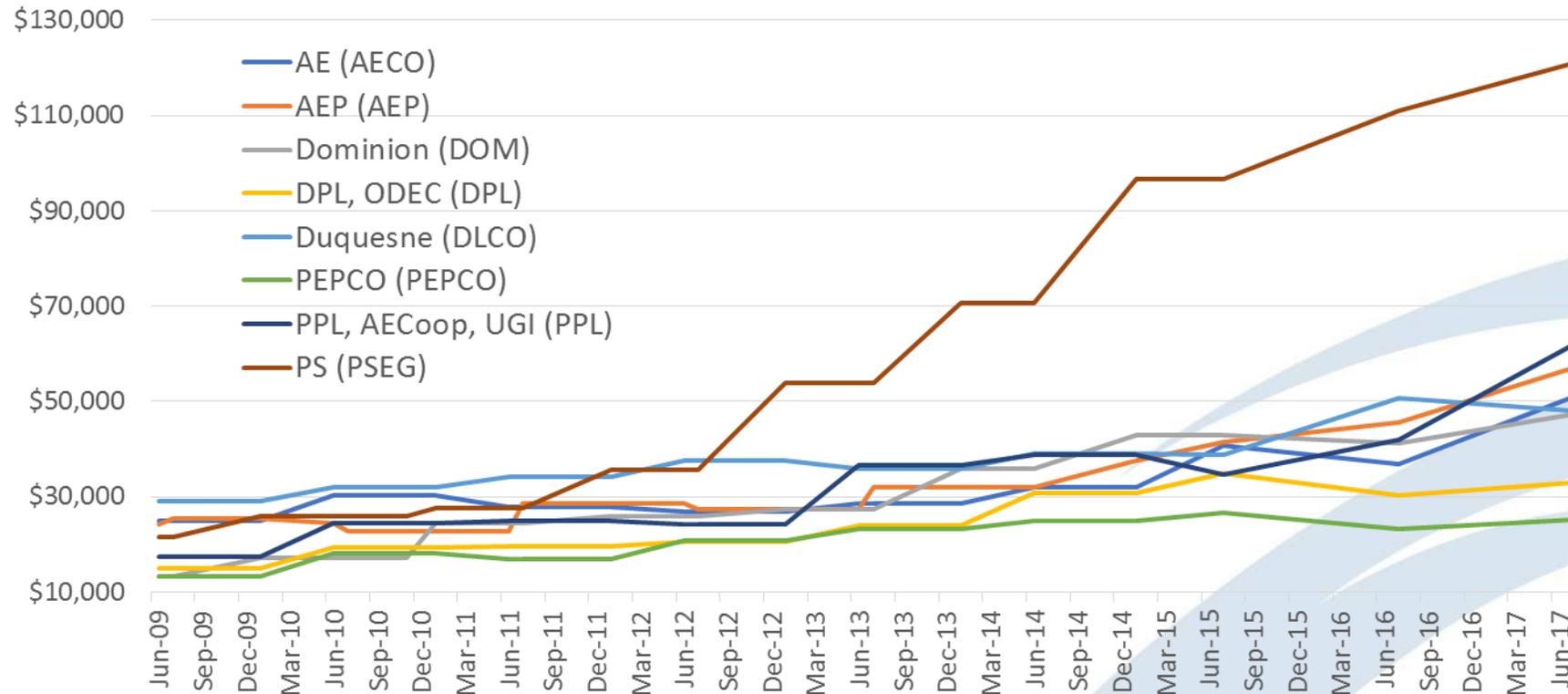
*through September 2017
in millions of dollars*

Transmission Rate Increases by Transmission Owner



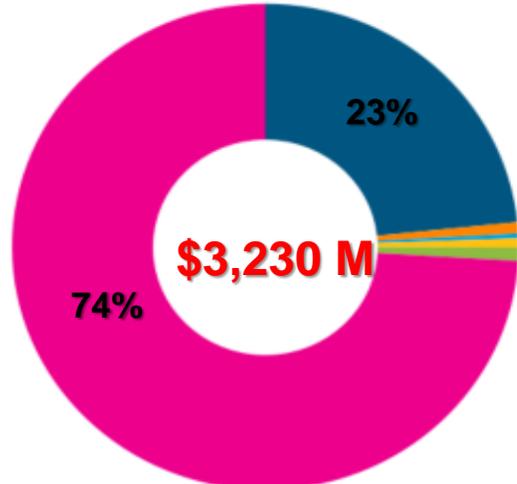
Transmission Rates by Transmission Owners 2009-2017 (\$MW/year)

Transmission Rates by Transmission Owner, 2009 to
2017 (\$/MW-year)





Estimated Cost of Baseline Projects Approved by PJM Board

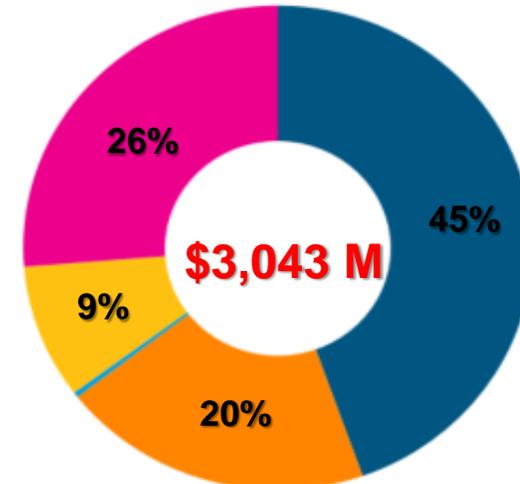


- PJM's Baseline Projects 13%
- TO's Baseline Projects 38%
- TO's Supplemental Projects 49%

Baseline Load Growth Deliverability & Reliability	\$755
Congestion Relief - Economic	\$24
Generator Deactivation	\$10
Operational Performance	\$21
Short Circuit	\$28
TO Criteria Violation	\$2,392

New Projects in 2017 Baseline Project Drivers

Estimated Cost of Supplemental Projects Presented by TOs to the TEAC



Equipment Material Condition, Performance and Risk	\$1,358
Operational Flexibility and Efficiency	\$603
Infrastructure Resilience	\$11
Customer Service	\$273
Other	\$0
Multiple Drivers	\$798

www.pjm.com

Note: Some values on this chart differ from the one published on 1/11/2018. 27 projects for a total of \$24.8M was misidentified as Load Growth rather than Short Circuit.

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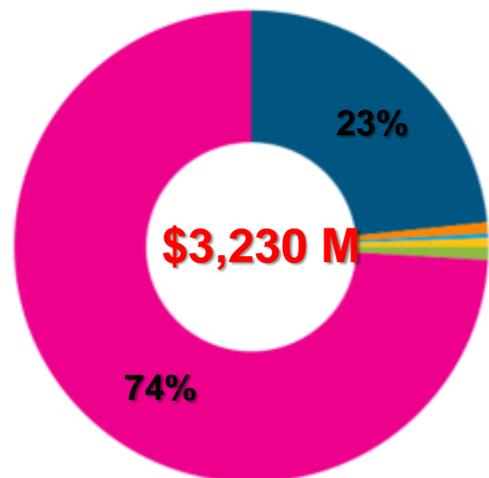
PJM©2018





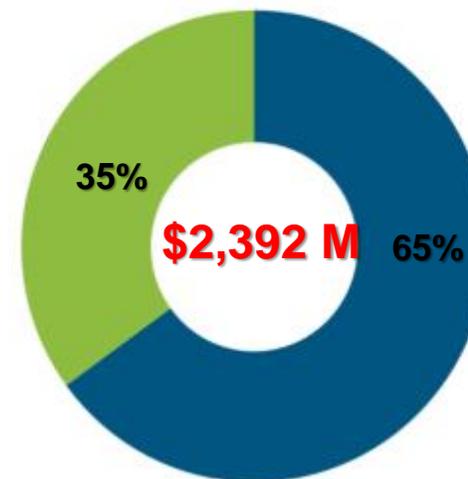
New Projects in 2017 Baseline Project Drivers

Estimated Cost of Baseline Projects Approved by PJM Board



- **65% of TO “Criteria Violation” Baseline Projects were associated with End-of-Life Drivers**
- **48% of all Baseline Projects**

Estimated Cost of Baselines Projects Driven by TO Criteria Violations



Baseline Load Growth Deliverability & Reliability	\$755
Congestion Relief - Economic	\$24
Generator Deactivation	\$10
Operational Performance	\$21
Short Circuit	\$28
TO Criteria Violation	\$2,392

Aging Infrastructure	\$1,554
Other TO Criteria	\$838

www.pjm.com

Note: Some values on this chart differ from the one published on 1/11/2018. 27 projects for a total of \$24.8M was misidentified as Load Growth rather than Short Circuit.

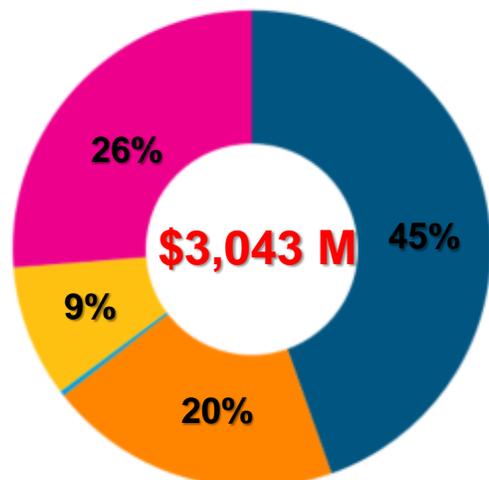
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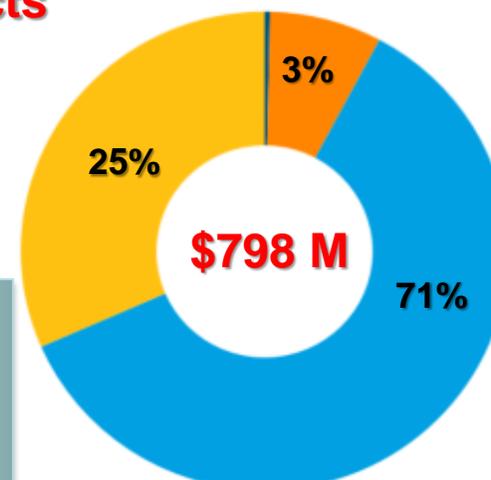
New Projects in 2017 Supplemental Project Drivers

Estimated Cost of Supplemental Projects Presented by TOs to the TEAC



- 63% of TO Supplemental Projects were associated with End-of-Life Drivers

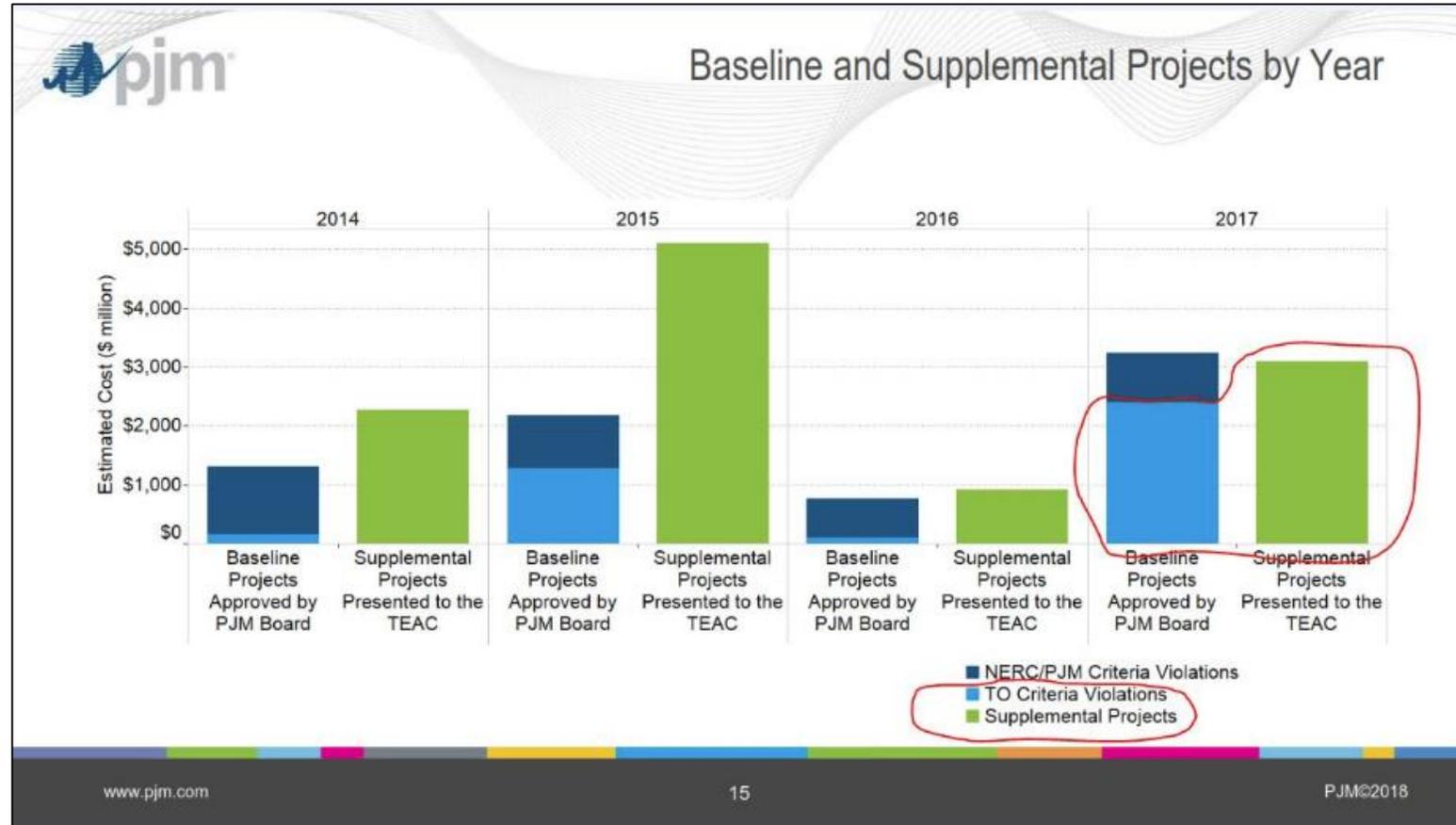
Estimated Cost of Supplemental Projects with Multiple Drivers



Equipment Material Condition, Performance and Risk	\$1,358
Operational Flexibility and Efficiency	\$603
Infrastructure Resilience	\$11
Customer Service	\$273
Other	\$0
Multiple Drivers	\$798

Equipment Material Condition, Performance and Risk / Customer Service	\$3
Equipment Material Condition, Performance and Risk / Infrastructure Resilience	\$59
Equipment Material Condition, Performance and Risk / Operational Flexibility and Efficiency	\$484
Operational Flexibility and Efficiency / Customer Service	\$252

Approximately 88% of 2017 projects were TO-driven



Historical Transmission Investment in the U.S.

Scope of ISO/RTO Oversight in U.S. Transmission Investments

Of \$70 billion in transmission investments by FERC-jurisdictional TOs in ISO/RTO regions over the last 4-5 years, almost **half was made without full ISO/RTO and stakeholder engagement** in the planning process

- Investments based on local planning processes of incumbent TOs are only subject to limited ISO/RTO review
- FERC’s August 31 Order (Docket No. EL17-45, still subject to rehearing): only transmission “expansion” activities are subject to full regional planning requirements

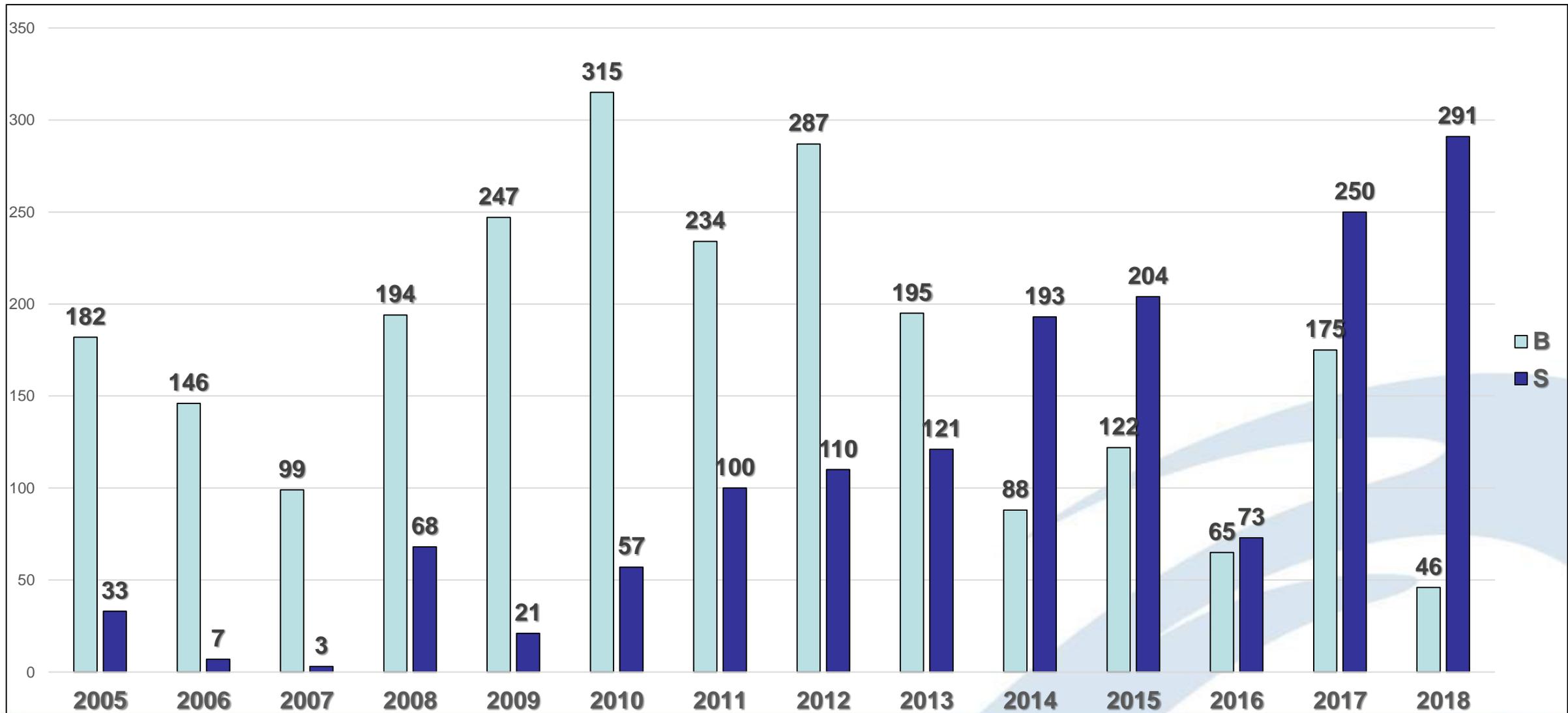
Transmission Investments Subject to Full or Limited Review in ISO/RTO Regional Planning Processes

	Years Reviewed	FERC Jurisdictional Additions by Transmission Owners (nominal \$million, based on FERC Form 1 Filings)	Investments Approved Through <u>Full</u> ISO/RTO Planning Process (nominal \$million)	% of Total FERC Jurisdictional Investments Approved Through <u>Full</u> ISO/RTO Planning Process	% of Total FERC Jurisdictional Investments with <u>Limited</u> ISO/RTO Review
CAISO	2014 - 2016	\$7,528	\$4,043	54%	46%
ISO-NE	2013 - 2017	\$7,488	\$5,300	71%	29%
MISO	2013 - 2017	\$15,530	\$8,068	52%	48%
NYISO	2013 - 2017	\$2,592	n/a	n/a	n/a
PJM	2013 - 2017	\$31,469	\$14,458	46%	54%
SPP	2013 - 2017	\$6,202	\$4,226	68%	32%
Total	-	\$70,810	\$36,095	53%	47%

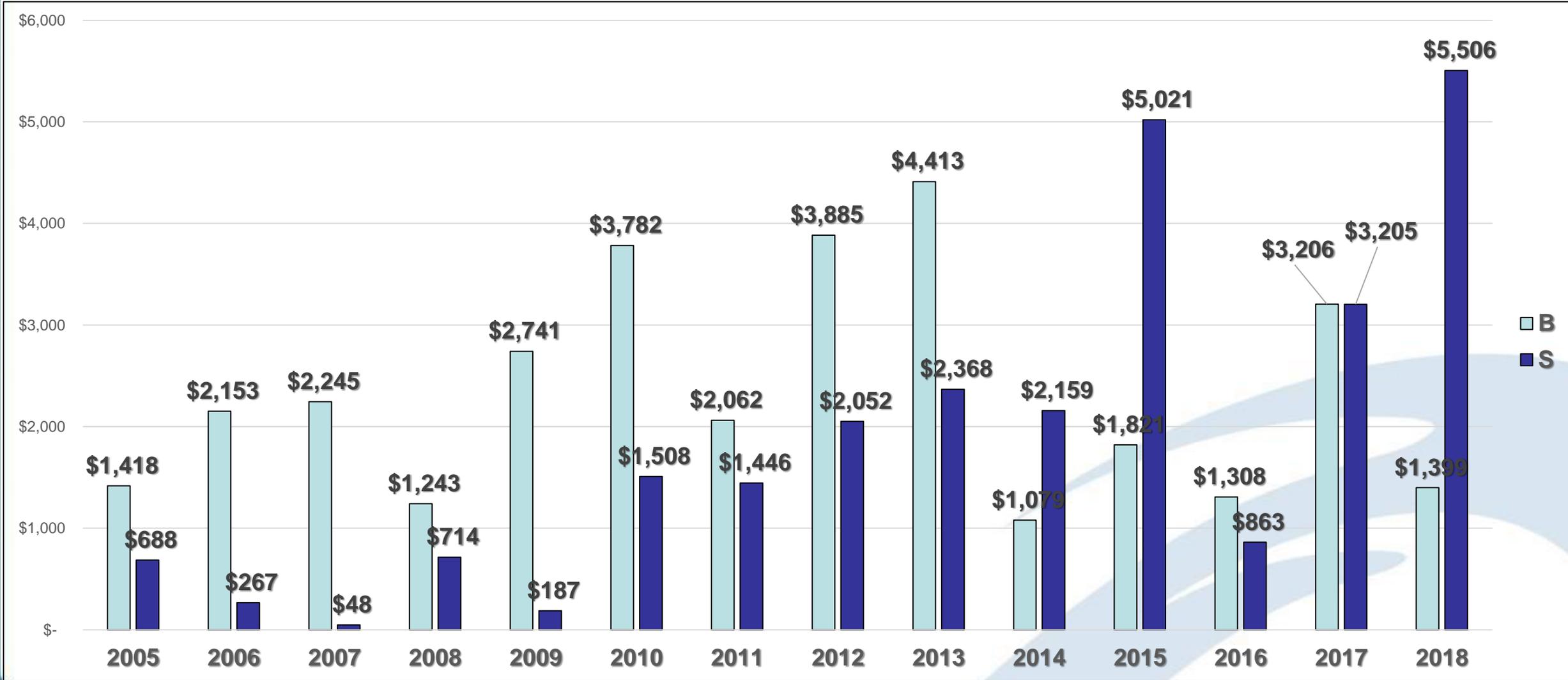
Sources & Notes: Data based on FERC Form 1 and ISO/RTO Tracking Reports. CAISO data reflects only select transmission additions/approved investments of PG&E, SCE, and SDG&E for 2014 -2016, based on available data. Aggregate investment for each ISO/RTO reflects total FERC Form 1 transmission additions over indicated time periods. Investments approved by ISO/RTO reflects total value of transmission additions placed in-service over indicated time periods, approved through ISO/RTO processes.

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Number of PJM TO's Baseline Vs Supplement Projects By Year of Proposal



Cost of PJM TO's Baseline Vs Supplement Projects By Year of Proposal



From the Data...

- 2018 cost of Baseline projects is 40% **below** annual average cost since 2005
 - \$2.34B vs \$1.4B
- 2018 cost of Supplemental Projects is 296% **above** annual average cost since 2005
 - \$1.859B vs \$4.2B
- This year will be the most transmission cost (\$) PJM has ever incorporated into the RTEP including the largest amount supplemental project cost
 - YTD \$6.9B (Baseline & Supplemental), (\$5.5B Supplemental). Will be higher!
- Due to the large investments made in past RTEP cycles there are a limited number of remaining Baseline violations

Frequent news stories about utilities shifting capital from generation to transmission.

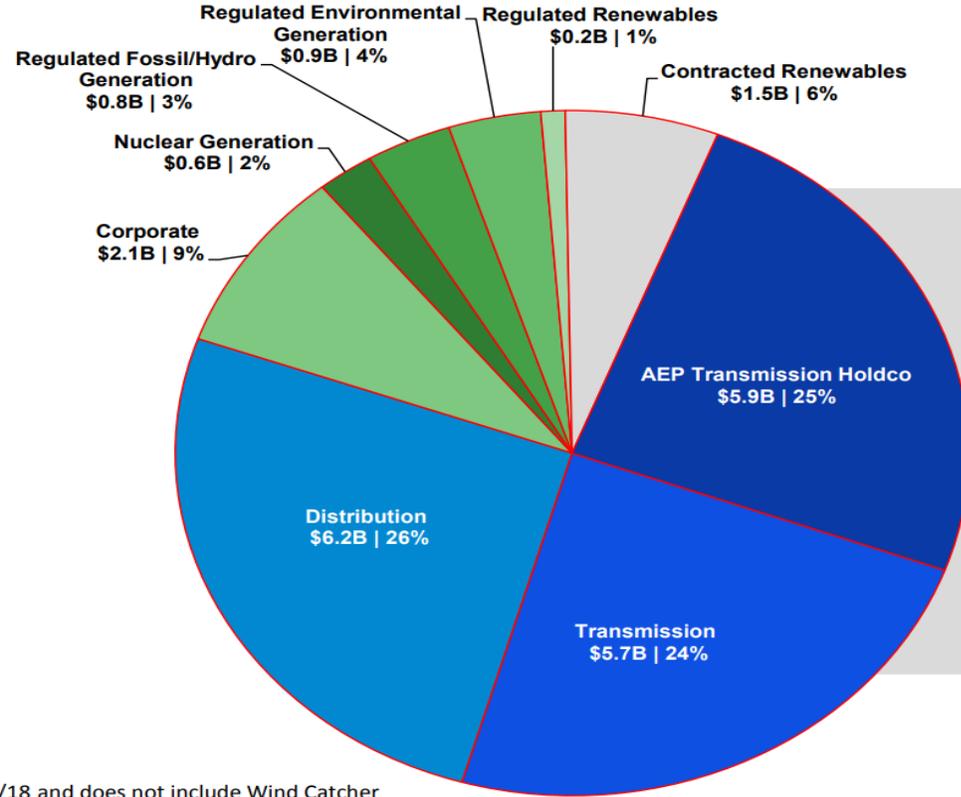
- **"More than three dozen regulated electric companies last year devoted almost half their more than \$120 billion in total capital spending to grid improvements,** according to the Edison Electric Institute, the trade association for investor-owned utilities. Spending on new power plants fell to less than a third of the total, the trade group said, as electricity demand decreased to its lowest since Recession-marred 2009.
- "Profits over the next decade will hinge on increased investment in updating and modernizing the distribution grid, Selmon said.
- **"Columbus, Ohio-based American Electric Power plans to invest nearly \$18 billion in grid improvements in the next four years,** across 11 states from Virginia to Oklahoma. AEP said it delivered a total shareholder return of 21 percent in 2017, and the investments will help keep profits growing at 5 percent to 7 percent year after year, chairman and chief executive officer Nicholas Akins said."

Source: https://columbus.edgemedianetwork.com/business/corporate/264563/utilities_pivot_from_power_plants_to_grid_work_for_profits. Edgemedianetwork, by Emery P. Dalesio (August 27, 2018).



AEP Consolidated Capital Forecast

\$24B Cap-ex: 2018 - 2021



100%

of capital allocated to regulated businesses and contracted renewables

75%

allocated to wires

Updated 07/25/18 and does not include Wind Catcher

Source: AEP 2nd Quarter 2018 Earnings Release Presentation (July 25, 2018), available at: <http://www.aep.com/newsroom/resources/earnings/2018-07/2Q18EarningsReleasePresentation.pdf>



Trends

- Aging infrastructure driving lots of investment
 - In PJM all aging infrastructure planning is based on either TO criteria via Form 715 or Supplemental Projects.
- Should aging infrastructure be replaced in kind?
 - The transmission grid we are using today was not built for free flowing competitive markets and we are using the grid in a way that its original designers never contemplated
 - Load growth flat or negative
 - Increase in renewable resources
 - Increase in intermittent, \$0/MWh resources
 - Change in economic life of units due to accelerated obsolescence
 - Distributed generation
 - Smart Grids

Trends

- Are current cost allocation rules driving planning?
 - Beneficiary pays; are we properly identifying benefits and timeframes?
 - What is local?
 - Periodic restudy?
- Are current Order 1000 Competitive Transmission rules driving planning?
- Perceived “failure” of competitive markets are driving capital into lower risk regulated business for shareholder gain
- Paradigm shift as load becomes more flexible and renewable generation inflexible

Trends

- Interregional coordination is still tricky
 - Different planning approaches; different market rules
- The world is significantly different than when original transmission facilities were built; Upcoming changes will be even more transformative
 - 22 Years into Organized Markets
 - The way we plan the transmission system must evolve to reflect the revised industry structure and recognize new drivers of competitive wholesale markets, public policy and regional/inter-regional coordination
- Transmission is not a fungible substitute for generation or demand response
 - Regulated asset
 - Needed to facilitate competitive generation and
 - To provide opportunity for the growth of new resources
 - Without which competitive wholesale markets cannot exist

Underbuilding vs Overbuilding?

- Can't know absent coordinated, holistic regional and inter-regional planning
 - Lots of building outside of the processes
- Concerned about stranded transmission investment
 - Recall stranded generation
 - Exponential increases in transmission costs can drive customers off grid
- Concerned that large expansion of underlying grid via planning outside of the RTO/ISO process will preclude more cost effective regional and interregional solutions
 - Is replacement of lower voltage aging infrastructure masking regional transmission opportunities?